

# California Inspection and Maintenance Review Committee

# Smog Check II Evaluation Executive Summary

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## 1. Goals of the IMRC Smog Check Evaluation

The Smog Check Program is intended to reduce air pollution emissions from vehicles by encouraging better ongoing maintenance of vehicles, and ensuring the repair of vehicles with excessive emissions and broken or tampered emissions control systems. Smog Check targets three types of pollution from vehicles: hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>), and carbon monoxide (CO). The Inspection and Maintenance Review Committee (IMRC) has attempted to answer the following four general questions about Smog Check:

1. To what extent is the Smog Check Program reducing the emissions of on-road vehicles, and does program effectiveness change over time?
2. What underlying causal factors make the Smog Check Program more or less effective?
3. What is the cost and cost effectiveness of Smog Check?
4. How can the effectiveness and cost effectiveness of the Smog Check Program be improved?

This report presents the findings of the IMRC on the Smog Check Program. Recommendations that follow from the study will be considered for adoption by the IMRC in July.

## 2. Findings

Major findings from the IMRC Smog Check Evaluation include the following:

### 2.1. Program Effectiveness

- The Enhanced Smog Check program achieves substantial emission reductions, the vast majority of which last for at least one year for vehicles that fail, then pass their Enhanced Smog Check.
- Roadside emissions tests indicate that the Enhanced program is reducing fleet emissions by 17% for HC, 28% for CO, and 9% for NO<sub>x</sub>.
- A single two-year cycle of the Enhanced Smog Check Program prevents *tailpipe exhaust* emissions of approximately 86 tons per day of HC, 1,686 tons per day of CO, and 83 tons per day of NO<sub>x</sub> from the motor vehicle fleet, based on measurements made under Smog Check test conditions. Based on uncertainties in the value of several key parameters required to generate these estimates, actual benefits could be as low as 40, 864, and 59 tons per day, or as high as 116, 2,235, and 93 tons per day, respectively, for HC, CO, and NO<sub>x</sub>. These results are summarized in Table ES-1.

**Table ES-1. Estimated Enhanced Smog Check Tailpipe Emission Reductions in Tons Per Day. Lower- and Upper-Bound Estimates Reflect Uncertainties in Parameters Necessary to Calculate Benefits.**

	<b>HC</b>	<b>CO</b>	<b>NO<sub>x</sub></b>
Lower Bound	40	864	59
<b>Best Estimate</b>	<b>86</b>	<b>1,686</b>	<b>83</b>
Upper Bound	116	2,235	93

- More than 90% of all emission reduction benefits can be attributed to vehicles more than 10 years old, even though such vehicles represent only half of those tested in the program.
- The Enhanced Smog Check program appears to achieve substantial emission reductions beyond those of Basic Smog Check. These include the prevention of roughly 50 to 55 tons per day of HC exhaust, 800 to 950 tons per day of CO exhaust, and 25 to 80 tons per day of NO<sub>x</sub> exhaust emissions.
- Average HC and CO emissions of vehicles that *pass* their initial Enhanced Smog Check increase steadily and substantially over the next 6 months and then level off.

## **2.2. Smog Check Test Failure Cut Points**

- Current Smog Check failure cut points are stringent enough to identify the vehicles that account for at least 85 to 90 percent of potential Smog Check emission reduction benefits.
- The failure cut points used to generate California's Smog Check SIP emission reduction target would increase Smog Check failure rates, failing many vehicles with marginal emissions that could provide few additional emission reduction benefits.

## **2.3. Program Avoidance**

- Ten percent of vehicles failing their initial test (1.3% of all vehicles) never receive a passing test. These vehicles have HC emissions 81% higher, and NO<sub>x</sub> emissions 15% higher, on average, than vehicles that eventually pass their Smog Check test. About one-third of these vehicles were observed driving in Enhanced areas one year after testing.
- An additional 5% to 10% of vehicles observed on road are registered in Enhanced areas and eligible for Smog Check testing, but there is no record of them reporting for testing. More research is needed to better quantify the number of vehicles avoiding Smog Check testing altogether.

## **2.4. Station Performance**

- Analysis of Smog Check test data indicate that Test-Only stations and Gross Polluter Certification stations, a type of Test-and-Repair station, are equally effective in achieving emission reductions from Gross Polluter vehicles.
- Other types of Test-and-Repair stations appear to achieve lower fleet emissions reductions than those achieved at Test-Only stations. However, it is not clear that this is because Test-Only stations are inherently more effective at identifying high-emitting vehicles and ensuring that they are repaired. The data indicate that two other possible causes are (1) the vehicle fleet reporting to Test-Only stations has higher initial emissions than the fleet reporting to Test-and-Repair stations, and (2) Test-Only stations have been more closely monitored than Test-and-Repair stations. The latter possibility is supported by the finding that Gross Polluter Certification stations and Test-Only stations, both of which are more closely monitored by BAR than are other stations, are equally effective in reducing emissions from Gross Polluter vehicles.

## **2.5. Emissions of Exempt Older Vehicles**

- Pre-1974 model year vehicles that are currently exempt from the Enhanced Program account for 4% to 8% of on-road tailpipe emissions, depending on the pollutant. Non-tailpipe (evaporative) HC emissions were not measured for this study, but are also likely significant.

## **2.6. High Emitter Profile**

- Based on Smog Check emissions levels and failure rates of HEP and non-HEP vehicles, the high emitter profile does no better at identifying high-emitting older vehicles, and does slightly better at identifying high-emitting newer vehicles, than random selection.
- The vehicle emissions data used to generate the HEP are now several years out of date. New data might improve HEP performance. In addition, it is possible that directing motorists to test-only stations using the HEP changes motorists' behavior, resulting in program avoidance that lowers the apparent effectiveness of the HEP.

## **2.7. Smog Check Costs**

- Smog Check costs about \$850 million per year statewide, with about 70 percent of costs generated by the Enhanced Program.
- About 28 percent of Smog Check costs are directed toward vehicle repairs. The remaining 72 percent of costs are devoted to emission testing, program administration, and the cost of motorists' time.
- Smog Check repairs increase average fuel economy of the vehicle fleet, thereby offsetting some of the costs of Smog Check. The level of these savings is uncertain,

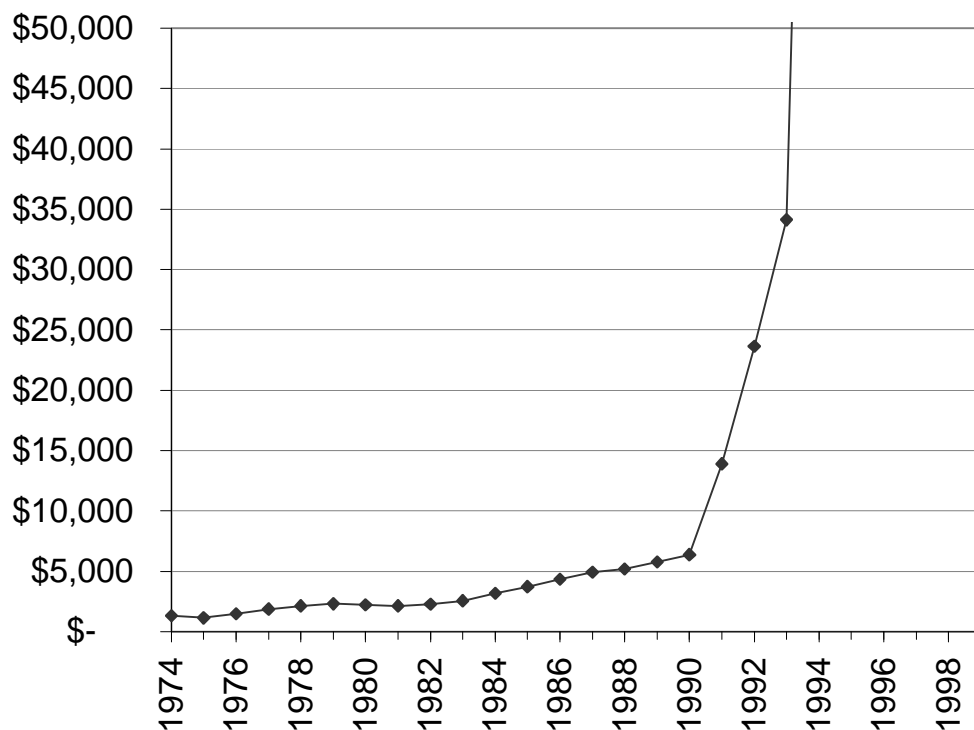
but could be in the range of \$50 million to \$100 million per year (given current gasoline prices).

- Enhanced Smog Check costs motorists an average of about \$65 if their cars pass and about \$230 if their cars fail. Gasoline savings offset some of the costs to owners of failing vehicles. Testing costs make up the largest share of costs for passing vehicles, averaging about \$48. Additional costs include a Smog Check certificate, pretests for some vehicles, and imputed costs for motorists' time. Failing vehicles incur additional costs for repair and retesting, with repair accounting for an average of about \$128 per vehicle.
- Owners of older cars and those with lower incomes are more likely to own a car that fails Smog Check and thus to incur the highest costs.

## **2.8. Smog Check Cost Effectiveness**

- Enhanced Smog Check costs about \$5,400 per ton of pollution reductions. This estimate includes estimates of non-tailpipe HC benefits due to gas cap pressure testing and gasoline cost savings due to improved fuel economy. This cost effectiveness is competitive with the cost effectiveness estimated for other major mobile source air pollution reduction measures such as low-emission vehicles, vehicle retirement, and reformulated gasoline.
- In 1999, pre-1991 vehicles accounted for about 95 percent of Enhanced Smog Check benefits, but only about 60 percent of total costs.
- Smog Check's cost per ton of emission reductions is much lower for older vehicles than for newer vehicles. Emission reductions cost on average about \$3,500 per ton for vehicles of at least 10 years of age (1990 and older model years in calendar year 1999) and \$35,000 per ton for vehicles less than 10 years old (1991 and newer in 1999). Figure ES-1 displays an estimate of Smog Check cost effectiveness by model year for calendar year 1999.

**Figure ES-1. Cost Effectiveness of Smog Check by Model Year Based on 1999 Data  
(in \$/ton of emission reductions)**



### **3. Context for the IMRC Smog Check Evaluation**

Smog Check is a key part of California's strategy for meeting federal and state air pollution health standards. The IMRC's Smog Check evaluation attempts to determine both how effective the program is in reducing emissions, and, perhaps more important, understand what underlying factors make the program more or less effective. Only by understanding how the program works can one develop appropriate recommendations for making the program more effective and more cost effective.

To achieve this goal, the IMRC analyzed many dimensions of the performance of the Enhanced Smog Check program. These include: (1) emission reductions, (2) motorist avoidance, (3) Smog Check station type performance, (4) effect of vehicle emissions variability on program effectiveness, (5) deterioration of failing and passing vehicles with time after Smog Check, (6) the effect of emission test failure cut point changes on potential program benefits, and (7) the relative cost effectiveness of program components. All of these analyses in our report are based on data that directly measure program performance. The IMRC's goal in taking this approach is to provide policymakers and the public with the tools to make sound decisions about the future of the program.

***IMRC and ARB Smog Check Evaluations Serve Two Different Purposes.*** Both the IMRC and the ARB have generated evaluations of the performance of the Smog Check Program. However, these two separate evaluations serve different purposes. The IMRC attempted to evaluate underlying factors that influence program effectiveness. The ARB had the charge of estimating total program emission reductions, how these reductions compare with California's obligations under its State Implementation Plan (SIP), and what changes to the program will increase the state's ability to meet SIP requirements. The SIP is California's federally enforceable plan for meeting the requirements of the federal Clean Air Act.

Responsibility for evaluating California's SIP compliance rests solely with the ARB. Therefore, the ARB report should be used for purposes of assessing SIP compliance.

SIP requirements are based on modeling rather than actual program data. The vehicle emission models (known as the "EMFAC" series of models) on which SIP requirements are based do not fully or accurately reflect the factors that make the actual Smog Check program more or less effective. Therefore, policies that receive emission reduction "credit" in the model are not necessarily the policies that would be best for improving actual program performance. It is therefore important to distinguish between how policy changes to Smog Check would affect SIP credit in the model and how such changes would affect the actual effectiveness and costs of the program.

The IMRC report is intended as an assessment of the real-world performance of the Smog Check program and not as an assessment of Smog Check performance in terms of SIP requirements. Table ES-1 summarizes the program components analyzed by the IMRC and the ARB.

***Receipt of Federal Transportation Funds Depends on Meeting SIP Requirements.*** Although program changes that would help California meet its SIP requirements do not necessarily coincide with program changes that would improve real-world program effectiveness, the importance of meeting the SIP requirements should not be underestimated. According to ARB, \$1.5 billion per year in federal transportation funds depend on California's Clean Air Act nonattainment regions showing that their regional transportation plans (RTPs) and transportation improvement programs (TIPs) will not cause these regions to exceed their respective emissions budgets in the SIP. To the extent that Smog Check falls short of its required SIP reductions, transportation funds may be in jeopardy.

The high stakes and legal requirement to demonstrate with apparent certainty SIP compliance means that ARB, local air districts, and metropolitan planning organizations must focus on producing and using a single tons-per-day number for emissions reduced by the Smog Check program. Yet this number is inherently uncertain. During the next few months, the state will need to find a way to both meet the legal requirements of the SIP while ensuring that the Smog Check program meets reasonable criteria for real-world effectiveness and efficiency.

**Table ES-1. Comparison of Scope of ARB and IMRC Smog Check Analyses**

<b>Program Component</b>	<b>ARB</b>	<b>IMRC</b>
<b>Tons-per-day Reduction Estimate</b>	Based on Random Roadside ASM data and EMFAC2000 modeling plus several assumptions and estimates	Based on Random Roadside ASM data, Smog Check test records, and remote sensing data plus several assumptions and estimates
<b>Effect of Cut Point Changes on Potential Emission Reductions</b>	Estimate based on EMFAC7F and EMFAC2000 modeling	Estimate based on Random Roadside ASM and Smog Check test data
<b>Station Performance</b>	Not addressed	Analysis and discussion of relative performance of different station types based on Smog Check test data
<b>Emission Deterioration with Time Since the Last Smog Check Cycle</b>	Not addressed	Analysis of emission deterioration out to one year after Smog Check based on Smog Check test data and remote sensing data. Pending analysis of deterioration over longer periods of time as new data become available.
<b>Extent and Effect of Motorist Avoidance of Smog Check Requirements</b>	Not addressed	Analysis of vehicles that fail and then never pass based on Smog Check test data, Random Roadside ASM data and remote sensing data. Pending analysis of non-registration and re-registration outside of Enhanced areas based on DMV registration data and remote sensing data
<b>Effect of Vehicle Emissions Variability on Program Benefits</b>	Not addressed	Analysis of missed “should-fail” vehicles due to emissions variability based on Smog Check test data
<b>Effect of Fraud on Program Effectiveness</b>	Not addressed	Discussion of fraud and enforcement statistics. No estimate of effect of fraud on program benefits due to lack of appropriate data.
<b>Program Costs and Cost Effectiveness</b>	Not addressed	Estimated program costs using Smog Check data and cost surveys  Estimated relative cost effectiveness of program components, such as individual model years and cut point changes  Estimated costs to individual motorists
<b>Effect of Adding or Subtracting More Vehicle Model Years to/from Program</b>	Estimate based on EMFAC7F and EMFAC2000 modeling	Estimate based on analysis of Smog Check test data, Random Roadside ASM data and remote sensing data.
<b>Effect of Expanding the Enhanced Program to More Areas of the State</b>	Estimate based on EMFAC7F and EMFAC2000 modeling	Not addressed
<b>Performance of Smog Check Relative to SIP Target</b>	Estimate based on Random Roadside ASM data and EMFAC7F and EMFAC2000 modeling	Not addressed



***Uncertainties Are Inherent in the Available Data.*** Although the IMRC evaluation covers a broad range of program components, any evaluation of Smog Check inherently includes uncertainties, particularly in the area of emission reductions. Major sources of uncertainty include (1) unknown deterioration rates of failing vehicles in the absence of Smog Check, (2) limited information on deterioration rates of vehicles repaired due to Smog Check, (3) sampling bias in data used to estimate Smog Check benefits, and (4) uncertainty in the estimation of on-road emissions rates from Smog Check test data.

The IMRC evaluation includes a range of benefit estimates that reflects the uncertainty inherent in estimating tons-per-day emission reductions. The evaluation also includes a “best estimate” within the range of the upper and lower bounds. However, any single number for Smog Check effectiveness should be treated with caution, in order to avoid creating an unwarranted impression of certainty.

***Data Sources and Their Respective Advantages and Disadvantages.*** The IMRC had three major data sets available with which to analyze Smog Check benefits. These are the Smog Check test records stored in the Vehicle Information Database (VID), random roadside emissions testing performed by BAR, and on-road remote sensing. All of these data sets have advantages and disadvantages. For example, the VID data allow an assessment of many dimensions of program performance, including deterioration of emissions after Smog Check, vehicle emissions variability, Smog Check station performance, and program avoidance. No other data are currently available that allow an assessment of so many aspects of program performance. However, the VID data also have limitations. The VID data do not capture emission reductions due to repairs performed before the first Smog Check test. The emission deterioration analysis also had to be based only on the vehicles that had more than one Smog Check cycle in a year (this would occur due to a change of ownership). The results for these vehicles might not be representative of the fleet as a whole. In addition, the VID data do not account for the effects of Smog Check test fraud.

The random roadside ASM test data have the advantage of inherently including all factors that affect the outcome of the Smog Check process. These factors include potential pre-Smog Check repairs, motorist avoidance, and fraud. However, by themselves, the roadside data cannot shed light on the relative effect of these factors on program performance. There are also not enough roadside data to assess post-repair deterioration. In addition, data were collected at different locations in the state at different times. This appears to have created a bias that results in overestimation of emission reductions, because fleet-average emissions vary by region in the state. While there is no perfect data set for evaluating the program, the use of multiple sources of data allows both cross-checking of results among data sets, and evaluation of a broader range of program features.

Although data were available on many aspects of the program, it was not possible to evaluate all aspects of the program. For example, there were no data available on emission reductions due to gas-cap pressure testing. ARB predicted reductions from gas-cap testing using the EMFAC emission model. However, as noted earlier, estimates based on the EMFAC model are uncertain. In addition, even for features of the program that could be evaluated, our understanding remains incomplete to one degree or another.

Understanding of the program will improve as additional data become available in the coming months. For example, the IMRC plans a series of focus groups with motorists and mechanics to develop greater knowledge of how people behave in the program and of how the program affects them. In addition, with each passing month, additional Smog Check test records are collected and can then be used to determine emission deterioration rates of vehicles over longer periods of time. Roadside testing of vehicles also continues. These data can be used to measure overall program performance. A large-scale remote sensing program (e.g., more than a million measurements) would be another potential source of data. Such a program would provide information on a wide range of program performance diagnostics, including emission deterioration with time since Smog Check, motorist avoidance, and possibly Smog Check station performance.

#### **4. Additional Research**

There are many important Smog Check issues that could not be fully addressed given the data and time available. Specific uncertainties and limitations are described throughout the report. Additional research on the Smog Check Program should include the following:

- Additional study of program avoidance, including non-registration and fraudulent “re-registration” outside of Enhanced areas while still living and driving in Enhanced areas.
- Ongoing analysis of VID data to assess long-term persistence of repair benefits, station performance, and vehicle attrition rates.
- Systematic studies of Smog Check fraud rates and the degree to which fraud reduces potential program benefits.
- An extensive remote sensing data collection effort (i.e., more than a million vehicle measurements in various areas of the state) should be undertaken to provide on-road data to address program avoidance, persistence of repair benefits, and Smog Check station performance.